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NETWORK TECHNOLOGIES INC

WHITE PAPER

KVM SWITCH SOLUTIONS

March 1, 2001

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Introduction

Network Technologies Inc (NTI) recognizes that advances in computer technology, and the growing importance of the Internet in commercial transactions, have resulted in computer networks becoming more critical to businesses than ever before. Businesses today have increasing demands for space, equipment, and productive use of network administration personnel. Customers need a method to control multiple computers efficiently.

KVM (keyboard-video-mouse) Switches can provide flexible, efficient control of multiple computers while helping to minimize floorspace, equipment, environmental and administration costs. This White Paper explains:

- The purpose of KVM Switches.
- The technilogical development of KVM switches and how they work today.
- Design issues in choosing a KVM switch.
- How NTI, through its commitment to research and development of innovative KVM solutions, has addressed these design issues.
- What the future holds for KVM switch technology.

The first section, **"Simply Put,"** provides an introduction to KVM switches, including the issues to be considered in determining the KVM Switch solution that will best meet your needs.

The second section, **"Technically Speaking,"** is designed to provide a more detailed explanation of the technology utilized by KVM switches and how it impacts performance.

Simply Put

What is a KVM Switch?

KVM stands for: Keyboard – Video – Mouse.

The primary purpose of a ***KVM switch*** is to control more than one computer with ONE keyboard, ONE mouse and ONE monitor (also known as a *control console*). This is achieved with no special software or hardware modifications to the attached computers. Control of the computer at all stages of operation is achieved by utilizing the keyboard, video and mouse ports. It may help to begin by defining what a KVM switch is NOT:

- A KVM switch is not a software-based application such as PCAnywhere® or NetMeeting®. Software-based applications can be used to control the desktop of remote computers. However, these applications require that software be installed on each computer which will be accessed, which can interfere with other programs, and are not useful for working between different computer types and operating systems. They also do not allow the user to access the computer when the machine is at the *BIOS* level.
- A KVM switch is not a Telnet or Serial terminal connection. These connections can provide control to some lower-level features from a distance, but don't provide a *GUI* interface.
- A KVM switch is not a network. KVM switches replace or eliminate the need for networking, but can work in conjunction with a network.

KVM switches are a hardware-based solution to reduce the number of keyboards, monitors, and mice needed to control multiple computers. As illustrated in *Figure 1*, a KVM switch allows the user to control the selected computer (PC 2) via his or her keyboard and mouse, and view the video display from the selected computer on a monitor, as if directly connected. Select PC 1 at the switch, and you'll see and control PC1 – Select PC2, and you'll see and control PC 2.

KVM switches are commonly used in environments where one user needs to operate two or more computers, or where one or more administrators manage multiple computers from a central location. These include data centers, network operating centers, server rooms, software development and testing labs, help desks, departmental LANs and any desktop with multiple computers.

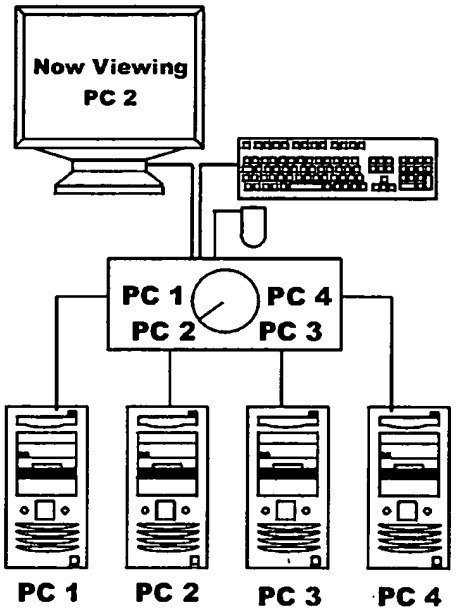


Figure 1 - Basic KVM switch configuration

Some typical applications include:

- A salesman wants to control a notebook computer using a desktop monitor, keyboard and mouse.
- A graphic artist wants to control two computers of different *platforms* (i.e., a PC and a Mac®) without cluttering his or her desk with two keyboards, two mice and two monitors.
- A network administrator wants the ability to control a large number of servers from both his office and the server room.
- A lab manager wants to be able to consolidate control of his lab computers and eliminate many keyboards, monitors and mice where space is at a premium.
- A manufacturer wants to allow workers on the shop floor and loading dock to conveniently control computers located in a server room, while protecting the computers from theft and harsh environmental conditions.
- A business owner wants to be able to control all of his computers from anywhere in the office, but needs to limit access to authorized personnel. KVM Switches in a Network Environment.
- A supervisor wants to be able to observe the desktops of employees to reduce downtime and prevent activities such as unauthorized web-surfing.

KVM Switches in a Network Environment

A KVM switch is not a substitute for networking computers, but rather can add functionality to a network. A *network* utilizes a combination of hardware and software to allow attached computers to share files, printers, and other resources. Computers attached to the network are called *workstations*. Each computer is independent, with shared privileges to the printer and server. In the application illustrated in *Figure 2*, any workstation can share files or use the printer or servers.

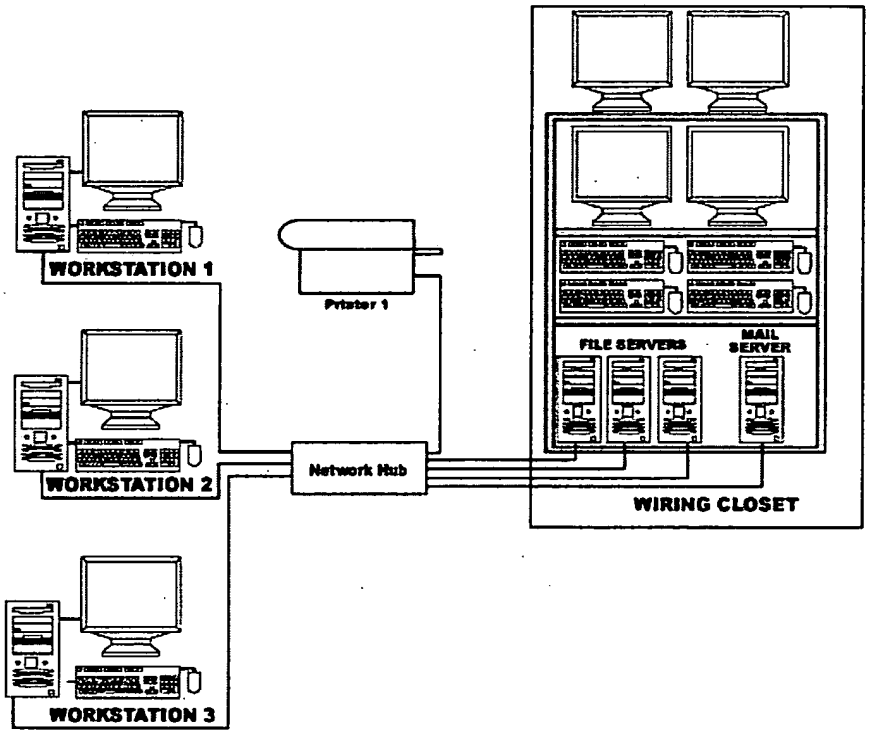


Figure 2 – Diagram of a Server-Based Network Configuration

The advantages of using a KVM switch in a network environment depend to some degree on the operating system being used.

Networks Utilizing a Windows® Op rating System

Users on a network with a Windows operating system can access files which reside on other workstations in the network (as long as the other workstations have been set up to allow them access). However, they cannot run programs that reside on the other workstations, or see that workstation's desktop on their monitor. In the application illustrated in *Figure* 3, KVM switches have been added that would provide these capabilities.

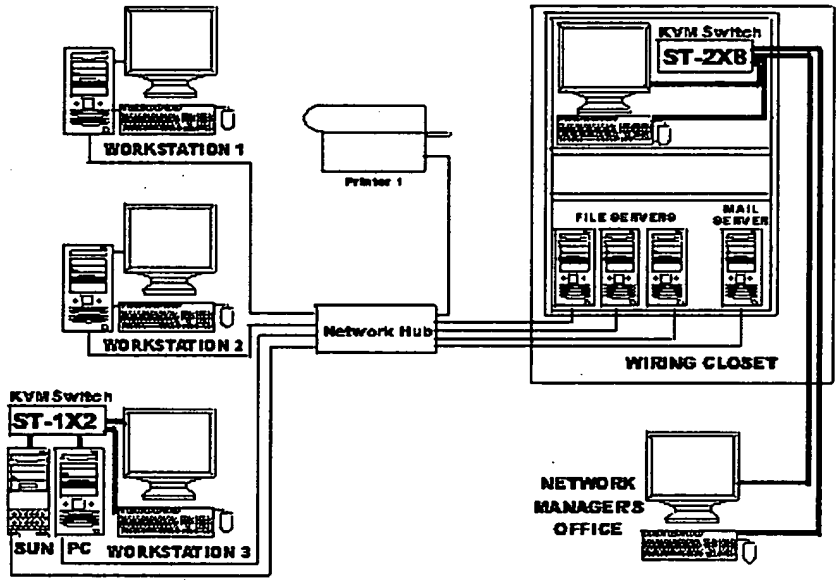


Figure 3 – Addition of KVM Switches to a Server-Based Network

Networks Utilizing a UNIX Operating System

A KVM switch can benefit a user with Xwindows-enabled workstations in the following ways:

- Direct access to the host console port. There are some privileges that the console retains which cannot be accessed from another workstation. *Figure 3* illustrates a modification of the application in *Figure 2*. Here, the KVM switches allow the user to control any workstation connected to the switch with full privileges.
- Speed of display. In cases where the UNIX network has high utilization, being directly connected to the server(s) can improve the rapidity with which the display is refreshed.
- A KVM switch requires no special software (such as Hummingbird), eliminating the cost of purchasing and updating such software.
- A KVM switch can boot multiple servers simultaneously, saving user time.

KVM switches are hardware based and transparent to the attached computers. KVM switches do not need special software because they do not change the way the computer operates or interacts with users. The modification illustrated in *Figure 3* includes some applications for KVM switching. A Sun® computer is added to Workstation 3's workspace. The user at Workstation 3 can now control both the Sun and PC computers with one keyboard, monitor and mouse. The addition of an NTI ST-2x8 multiple-user/multiple platform matrix KVM switch with *On Screen Display* (OSD) and *Security Features* in the server room will allow a network administration staff to control multiple computers (PCs, Suns and Macs) from both the network administration office and the server room.

Benefits of Using a KVM Switch

A KVM Switch can increase efficient use of resources by:

- Reducing equipment costs and space needs. If users work on more than one platform (for instance, a graphic artist who uses both a PC and a Macintosh®) or on multiple computers, a KVM switch can reduce the clutter of multiple monitors, keyboards and mice, and the cost of buying keyboards, monitors and mice. Fewer keyboards, monitors and mice can also mean less racks, cabinets, furniture and floor space are required, as illustrated in *Figure 4*.

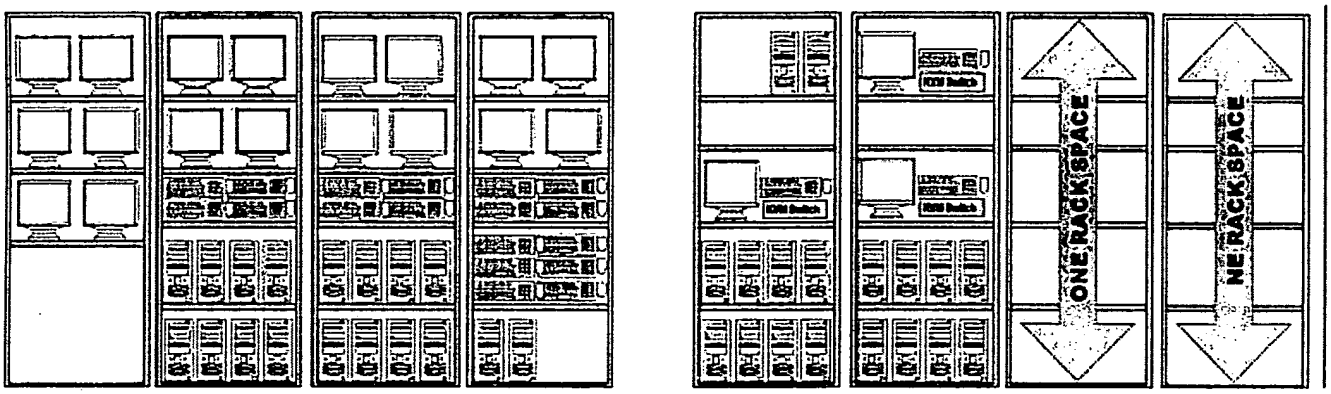


Figure 4 – Reconfigured server setup with three KVM switch controls. This actual example illustrates configurations of a bank of 18 computers at Microsoft before and after using KVM switches to consolidate control. Eliminating 15 keyboards, monitors and mice cleared out an almost two entire racks.

- Reduced environmental costs are achieved by eliminating redundant peripherals. According to the American Council for an Energy-Efficient Economy (Office Technology Consortium) and the Canadian Bureau of National Resources, even with 5.5 hours of power management per day, the average 14-inch color CRT monitor consumes about 145kW of energy per year, as illustrated in *Figure 5*. The power saving translates directly into utility cost savings. The elimination of the heat generated by extra monitors also saves HVAC expenses.

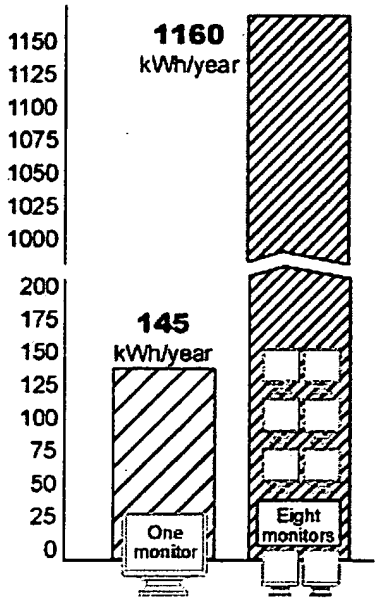


Figure 5 – Energy Savings. Annual energy usage of 14" CRT displays; operating 45 hours per week, 48 weeks per year with 5.5 hours of power management per day. Source: http://office.nrcan.gc.ca

- Increasing user productivity is achieved several ways:

  1) A KVM switch eliminates user time spent traveling from one control location to another. Instead, the user has the advantage of quickly switching between computers from ONE keyboard, ONE monitor and ONE mouse (or *control station*). KVM switches can allow extended control so that computers physically located in one area (for instance, a server room) can be controlled from another location (a network administrator's office).

  2) A *Universal KVM switch* can eliminate the need for the user to "switch gears" from one peripheral platform to another in order to control computers of different platforms (i.e., switching from a SUN keyboard to a PS/2 keyboard). This *translating switch* allows one keyboard, monitor and mouse to control all of the attached PCs, Suns and Macs.

  3) A *Universal Matrix KVM switch* can enhance employee productivity even further by allowing multiple users to control multiple computers of different platforms. Thus, several control consoles can be attached to the matrix switch and each console can independently control or simultaneously share any of the attached computers. There is no costly installation of networking hardware and software necessary. The network administrator can add control points wherever needed, such as the manufacturing floor or another department area.

Design Issues: What makes a good KVM switch?

NTI approached the design process by first identifying the concerns critical to producing KVM switches that meet the needs of today's work environment.

Please note: More detailed explanations of KVM switch technology and the causes of the problems mentioned below are contained in the **"Technically Speaking"** section.

Performance Concerns

- KVM switches should enable users to boot all computers connected to the switch simultaneously.
- The KVM switch should provide reliable control with freedom from crashes. This reliability is an important factor for businesses that cannot tolerate downtime, errors, or other catastrophic problems.
- KVM switches should support high video resolution (1900x1200) with no degradation of signal. This is necessary in order for users to take full advantage of the high-resolution display available in monitors commonly in use today.

Flexibility

- The ability to control multiple computer platforms from one keyboard, monitor and mouse is important, as many customers are adding Sun and/or Macintosh computer platforms to their PC networks.
- Peripheral compatibility – The variety of keyboards, monitors and mice on the market utilize many "standards." Compatibility issues can result in lockups that disrupt operations. The KVM switch should be designed to *translate* (seamlessly emulate) all variations of the different devices, including specialized devices such as the Microsoft Intellimouse®.
- Video switching is more complicated. KVM switches, unlike video cards or monitors, do not have a hard resolution limit that prevents them from handling anything higher than some particular resolution and refresh rate. The switch simply sees an analog signal and passes it through. Signals with a higher resolution and refresh rate require greater *bandwidth*. If the bandwidth requirements exceed the capabilities of the cables, connectors or switching components inside the KVM switch, the picture can get fuzzy and distorted. Impedance mismatching issues can cause ghosting at higher resolutions. The resultant image on the monitor can become poor and degraded.

To ensure there is clean, clear video output, better switches *terminate* the video output of all the non-selected computers and actively buffer the selected one. This avoids poor imaging, ghost images, and other video anomalies. Users get a clear image with no ghosting or fuzziness.

In multiple platform KVM switches, internal circuitry also converts between the different *video formats*, depending on the selected computer.

While the information here has been greatly simplified, it may be sufficient to understand that KVM switches:

1) Take signals to and from the computer, keyboards, mice, video cards and monitors.
2) Translate (convert) the signals as necessary.
3) Output the correct data according to the selected computer's platform.

- Expansion, Upgrade & Reconfiguration capability – the ability to integrate additional KVM switches and computers into a growing network, and to be able to transparently mix different hardware and software platforms, is critical for many applications.
- Today's computers increasingly utilize *USB*-standard peripheral ports. KVM switch configurations must be capable of:
  - Integrating USB-enabled computers with *legacy* (PS/2 style) computers.
  - Booting up all attached USB-enabled computers (PCs and Macs) simultaneously.
  - Present a sustained presence of keyboard and mouse to USB-enabled computers.
- Extending control to the user rather than requiring the user to travel to the control console.
- With computer networks expanding, extending control over a distance becomes more important. Utilizing a KVM switch configuration with cables and adapters can extend the control console (keyboard, monitor and mouse) to the user's workspace, rather than requiring the user to travel to the computer server room, frees up staff time to be used more productively.
- As computer networks expand, flexible methods of controlling the KVM switch become more important. While simple rotary knobs, front-panel buttons and keyboard commands may be sufficient for controlling only a few computers, larger applications benefit from an array of control options including liquid crystal display, *RS232* control, *infrared wireless remote*, and on-screen control (OSD) menus.

Security

- Security is an important concern today. Some switch manufacturers, such as NTI, provide security features that provide an additional layer of security in the work environment. One such feature is authorized access, which allows the network administrator to assign password protection and limit user access to servers attached to the KVM switch. Another method is *keylock access*, in which users must use a key that fits into the switch before the switch will allow controls to be operated.
- The ability to extend control over a distance, as discussed in the "Flexibility" section above, can be used to place computers in a physically secure environment without sacrificing control. Computers can be located in a limited-access, temperature-controlled server room, while the KVM switch allows the computers to be conveniently controlled from the shop floor, loading dock, etc.

Design Goals

NTI has demonstrated a commitment to investing in research and development in order to provide our customers with innovative KVM solutions. Taking into consideration the concerns outlined above, NTI next set out to produce a line of KVM switches that would **provide improved**:

- Reliability – eliminating the problem of the computer "losing" its connection with the keyboard and/or mouse
- Video Resolution – provide a clean and crisp video image at higher resolutions with no ghosting or fuzziness.
- Control of equipment, staffing and environmental costs.
- Security Features for control of user access.
- Efficiency/Flexibility, allowing users to:
  - Extend control to the user rather than requiring the user to travel to the control console.
  - Access additional control options, such as On Screen Display (OSD), RS232, and Infrared Wiresles Remote.
  - Boot all computers simultaneously.
  - Utilize the peripheral platform that best meets their needs.
  - Control multiple computer platforms through one control console.
  - Share control of the attached computers – multiple users control multiple computers.
  - Integrate control of both USB-enabled and legacy computers.
  - Allow *hot-plugging* of keyboards and computers while the switch is powered-on. NOTE: Computer should be powered-off when it is plugged into the switch.

NTI's KVM Switch Implementation

Reliability

To provide optimal reliability, NTI KVM switches feature a dedicated microprocessor to each attached computer for keyboard and mouse emulation 100% of the time. This ensures that all attached computers can boot and maintain connections. The individually *dedicated microprocessors* avoid the conflicts (and resulting downtime) that can otherwise occur when a single processor emulates the keyboard and mouse for multiple computers.

Control of costs

Besides the cost control features inherent in a KVM switch application (discussed above), NTI's line of KVM switches have been designed to incorporate additional features to expand the potential savings that can be achieved:

Using Expansion Features to Control Costs

Cascade Configuration

Cascading KVM switches provides a cost-effective method to expand KVM control as an application grows. In such an application, a second KVM switch (a *slave*) is connected directly to the first KVM switch (a *master*). In essence, this creates a larger capacity KVM switch. Cascading saves up-front costs because the user need only buy a KVM switch with the capacity currently needed. They do not need to guess at future needs because they can "grow" the KVM switch application as needs grow.

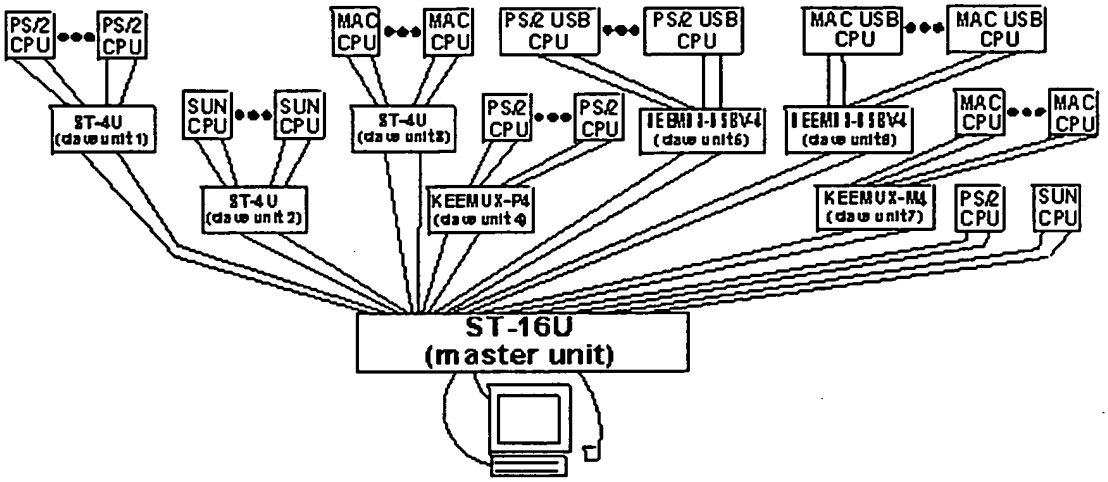


Figure 6 – KVM Switch used in a Cascade Application. All slave units must have the same number of ports. All computers attached to one slave must share the same platform.

NTI's line of KVM switches is designed to allow cascading. The following protocols must be followed in cascade applications:

- Any KVM Switch of 4, 8, or 16 ports can be used as a master or slave, with the exception of USB KVM switches, which can be used as a slave only. 32 port KVM switches can be used as a master only. If the master switch is a universal, the slaves can be universal or single-platform switches.
- Up to eight slave switches can be attached to a master, for a maximum cascaded application size of 152 ports. Slave switches can be universal or single platform switches.
- Universal switches (including the USB Universal switch) can be used as slaves, but all attached CPUs must be of one platform; the cables connecting the slave switch to the master switch support that particular platform.
- Each slave KVM switch must have the same number of ports. For instance, a user might purchase a 16-port KVM switch, then subsequently purchase several 4 port KVM switches to be used as slaves, as illustrated in *Figure 6.* All slaves added to this application must be 4 port switches.
- Individual computers can also be attached to the master switch in a cascade application.

A point to remember: As you cascade units, monitor resolution may degrade a bit. The degradation may seem negligible to the "untrained eye," but it is something to consider when you decide to add KVM switches and computers to an application.

Multiple Platform Control

Our Universal KVM switch allows one user to control up to 32 PC, Sun or Mac computers (or 152 computers with cascading) with just one keyboard, mouse and monitor. This switch allows for expansion of the network that is not limited to a particular platform.

Using a multiple platform switch as the master in a cascaded application does have one limitation, in that each slave unit is "uni-platform," as seen in *Figure 6.* That is, slaves can only have computers of the same platform connected to them and the cable between the slave and master unit must also support that platform.

(Additional benefits of Multiple Platform Control are discussed in the "Efficiency/ Flexibility" section below.)

Multiple User Control

NTI's line of KVM switches also includes two types of matrix KVM switches. Matrix KVM switches support multiple users and multiple platforms. There is no costly installation of networking hardware and software to allow for the multi-user feature. This feature lets the network administrator add control points wherever needed, such as the manufacturing floor or another department area. Two or more users can then simultaneously access the same computer to collaborate on solutions from different locations, although only one user at a time sholuld operate the accessed computer (other users should stop). All users see the same application screen.

Matrix switches save up-front costs because the customer need only purchase the plug-in modules or cables necessary to control their current network computers. They do not need to guess at future needs because they can "grow" the KVM switch setup as needs grow by adding or changing the plug-in modules or adapter cables necessary. NTI's matrix switches can also be used as a multiple-platform master switch in a cascade application.

The two types of matrix KVM switches which NTI offers are:

1) Modular Matrix KVM switches utilize plug-in modules for PC, Sun, USB and Mac computers and standard cables. Modules can be added or changed as needed.
2) Universal Matrix KVM switches are a low-cost matrix switch solution which accesses PC, Sun or Mac computers without the need for plug-in modules. Users can easily change platforms using adapter cables instead of being locked into a specific platform.

(Additional benefits of Multiple Platform Control and Matrix switches are discussed in the "Efficiency/Flexibility" section below.)

Efficiency and Flexibility

Consolidated Control of Computers

A multiple user/multiple-platform KVM switch application lets the network administrator scan all servers on the network, no matter what the platform. He or she can add or remove servers at will while the switch is powered-on, without causing a disruption, or using expensive cabling. The administrator can spot-check the operation of the network, troubleshoot, or make adjustments on any one of the servers from a single control station, whether that control station is in the server closet and/or at the administrator's desk.

Simultaneous Boot-Up

NTI uses a dedicated microprocessor for each keyboard/mouse, allowing administrators to boot all computers attached to the KVM switch in one operation.

Control Options

A variety of control methods is available for the NTI KVM switch line as standard or optional equipment. Below is a brief description of each:

- Liquid Crystal Display (*LCD*) provides a method to select and control attached computers by name from the front of the KVM switch itself.
- On Screen Display (OSD) allows users to utilize the keyboard or mouse to operate the KVM switch from menus superimposed onto the user's monitor. OSD on NTI's Matrix KVM switches includes advanced security features, discussed under "Security" below.
- RS232 Control – NTI KVM switches are RS232 compatible when you add the optional module to the switch. When you connect to the RS232 option, you can control the switch via a list of commands that appears on your monitor, without having to utilize the console buttons. This is very helpful when the KVM switch resides at a remote location; it eliminates the need for the user to get up and go to the KVM switch console in order to switch to different computer ports or to perform tasks.

- Infrared Wireless Remote capabilities are an option on most NTI KVM switches. This lets the user control the switch from up to 50 feet away, switching from one computer to another with two touches of a button. The remote unit has a seven-segment display that shows which computer is active. Wireless remote utilizes an optional transmitter (sold separately) and an optional receiver built into the switch to provide remote control.

Modes

NTI's KVM switches feature the following modes of operation which allow users to efficiently control multiple computers:

- In *Normal Operating Mode* the user can directly operate the selected computer with transparent presence of the NTI switch.
- *Scan Mode* causes the switch to automatically and sequentially display the video from each powered-on computer. Length of scan (the delay between changing ports) can be set for 2 to 255 seconds.
- *Command Mode* allows the user to give instructions to the switch (such as changing ports or mode of operation) through their keyboard. Keystrokes are not passed on to the computer.

Extension Options

Quality Cables

Cables have bandwidth response limits. Exceed the bandwidth they can handle, and your picture may get fuzzy. Resonance issues may also cause ghosting at higher resolutions.

The cables that NTI supplies with its KVM switch product line are the highest quality available on the market today. This regard for high quality standard cables ensures that your *video output* meets and exceeds your expectations.

Most NTI units are compatible with standard cables. NTI also carries a variety of optional extension cables and adapters for extending signals, and can create custom cables for our customers. These cables support high bandwidth (maximum 300MHz, which is the highest on the market) and are fire retardant for safety.

Cat5 KVM Extenders

NTI also offers Cat5 Extenders, which utilize Category 5 unshielded twisted-pair (UTP) cable (in-house telephone wire), to extend control up to 575 feet.

As illustrated in *Figures 8A and 8B*, Cat5 Extenders are available in both KVM and Video Only models. Each Cat5 Extender consists of a Local unit connected to the computer or NTI KVM switch and a Remote unit connected to the keyboard, monitor and mouse (or just the monitor in the Video Only model). The Local and Remote units are interconnected with Cat5 cable through their RJ-45 connectors.

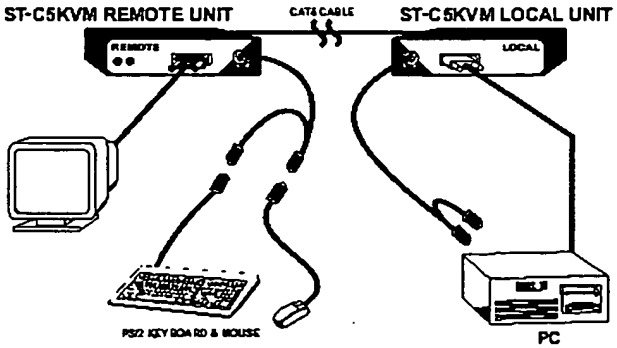


Figure 8A – Cat5 KVM Extender Application

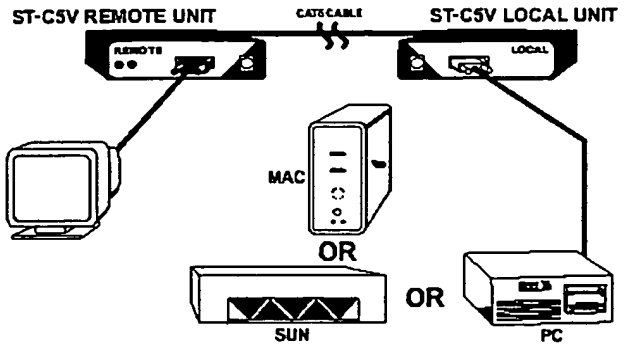


Figure B8 – Cat5 Video Only application

Crisp and clear 1280x1024 video resolution is supported. Automatic video equalization control compensates for image quality loss over long cables. The Cat5 KVM Extender has auto-equalization to provide the best image quality at any cable length. The Cat5 Video Only Extender requires manual adjustment of equalization to obtain optimum image quality.

Multiple Platform Control

Our Universal KVM switches support multiple platform control, allowing one user to control up to 32 PC, Sun or Mac computers (or 152 computers with cascading) with just one keyboard, mouse and monitor. Incorporating internal software that allows the KVM switch to "translate" the signals between the keyboard and mouse and the various computers, universal KVM switches allow expansion of the network that is not limited to a particular platform.

Most KVM switches support only PS/2 keyboards and mice. NTI's multiple platform KVM switches can be used with PS/2, Sun or Mac keyboards and mice; users choose the peripheral platform that best meet their needs.

NTI's unique keyboard hot-plug feature allows users to change their keyboard on the fly – even to a different keyboard platform – with no need to reboot the computer or power-off the switch.

Multiple User Control

NTI's line of KVM switches also include two types of Matrix KVM switches. Matrix KVM switches support multiple users and multiple platforms. As discussed in the "Control of Costs" section above, matrix switches utilize plug-in modules (Modular Matrix) or adapter cables (Universal Matrix) to allow multiple users to control computers of multiple platforms. The platform configuration is flexible – when administrators needs to add a computer, or change out an attached computer of one platform to a computer of a different platform, they need only add or change the plug-in module or adapter cable rather than replace the switch.

Expansion Flexibility

The Switch Expansion Unit (SEU), formerly known as the Multiplexor Box, combines up to 16 of NTI's switches to create a total capacity of eight users and 512 computers – all with true matrix switching. An application of matrix switching with the SEU is illustrated in *Figure 7*. All users can individually command or simultaneously share control of up to 512 PC, SUN or MAC computers without interfering with each other. Switches can be added as an operation grows.

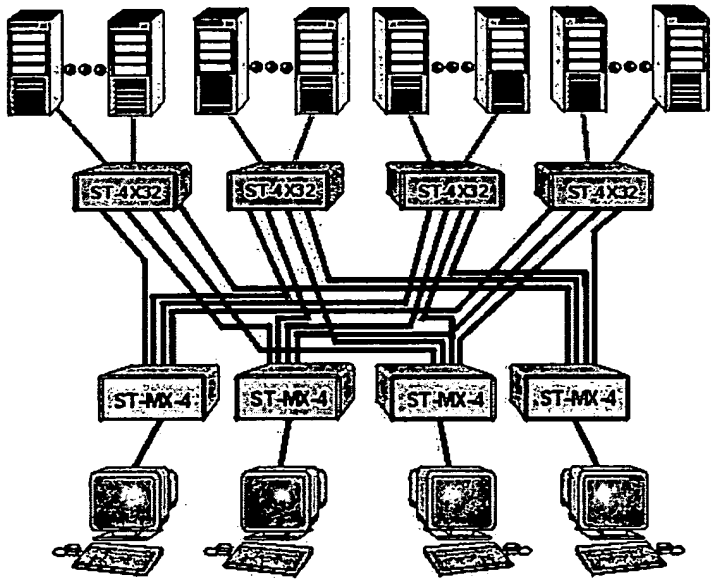


Figure 7 – Matrix KVM switches provide multiple user control.

Unique USB control

NTI's new Universal USB KVM switch allows one user to control up to 32 USB computers with one keyboard, mouse and VGA monitor. This switch is compatible with all USB-enabled PCs, UNIX computers and MAC G3/G4s.

To be fully USB-enabled, computers must have both the hardware and software to support the USB standard:

All Windows 98 and Windows 2000 PCs are fine with USB; Windows 95 OSR2 PCs can be equipped with a patch (contact your computer manufacturer for details). USB ports can be added to the PC's motherboard with an inexpensive PCI card, which the operating system recognizes automatically. Recent Macintoshes, such as the G3/G4s, have USB support. Any Mac with PCI slots should be able to handle a USB card. Mac OS 8.6 or later is preferred for USB. The latest Linux kernel has USB support.

This switch can also be used as a slave to control USB computers in a multiple platform configuration. This allows users to consolidate control of both legacy and USB-enabled computers in one configuration.

Our patented USB KVM switch technology allows NTI's USB KVM switch to present a sustained presence of the keyboard and mouse to all attached computers. This provides a unique benefit – all attached computers, both PCs and Macs, can be booted up simultaneously. Other manufacturers' USB switches do not have this technology. Other "USB KVM switches" operate as a USB hub with a video switch (that is, the USB connections are plugged in and out), and may require a sequential, separate boot-up of each attached computer. NTI's switch also supports Mac Power-on.

This technology also prevents computer crashes caused by operating system sensitivity to hot-plugging. Most operating systems (such as Windows 98, Mac G/4 OS and the HP6000 OS) are sensitive to hot-plugging to one degree or another. Since other switches operate as USB hubs, when you switch from one attached computer (PC 1) to another (PC 2), it will appear to PC 1 that the keyboard and mouse have been unplugged. This may cause the computer to break and it will need to be rebooted. The HP J5000 is particularly sensitive to this. NTI's USB KVM switch presents a sustained presence of the keyboard and mouse, and so switching from one computer to another does not result in crashes.

Analyzing Your Needs

Deciding What KVM Switch Fits the Environment

The first step in deciding what KVM switch product to purchase is to determine your needs. The following questions will help you form that determination:

Each KVM switch application would consist of the appropriate KVM switch products as well as all attached computers and peripherals. For example, lets look at two ways of handling the needs of three graphic designers. Each designer needs to control a PC and a MAC.

- One solution would be three individual applications, each with a 2-port KVM switch controlling a PC and a MAC with one keyboard, monitor and mouse.
- An alternate solution, if each graphic designer needs to be able to control all of the department computers, would be a matrix KVM switch attached to all three PCs and all three Macs, with three user control stations (keyboard, monitor and mouse). One application would provide all of the necessary control.

In deciding what type of KVM switch will fit an application, consider the following:

- How many computers do you need to control?
- How many different computer platforms (PC, Sun, or Mac) will be included?
- How many users need access to the computers?
- What type of monitor would be used to control the KVM switch?
- What type of peripheral connector ports do the computers have (USB or legacy)?
- What is the distance from the computer to the switch location and from the switch location to the keyboard, monitor and mouse?
- What is your budget for KVM switch products?

Future Trends in KVM Switch Technology

USB

The current trend in KVM switch technology is perfecting the Universal Serial Bus (USB) products. USB technology provides true plug-and-play capability to personal computers. You can add any external peripheral to a USB-equipped computer without adding an internal card or configuring the new device through software. As soon as you plug in a USB-compatible peripheral, the USB computer automatically recognizes the equipment.

Currently PC, HP J5000, Sun Blade 10000 and Mac G3/G4 computers are available which support the USB standard. We also offer a variety of USB hubs, cables, adapters and gender changers in our product line.

NTI is currently developing a new USB KVM switch with USB hub capabilities. This product would combine the advantages of NTI's patented USB switching technology (constant presence of keyboard and mouse for each attached computer) with the ability to support many USB devices on a USB hub built into the product. NTI's KVM switch would continue to present a constant presence of the

keyboard and mouse to each attached computer. Any of the attached computers would be able to utilize USB devices attached to the hub, such as ZIP drives, CD burners, scanners, printers, etc. The USB standard allows up to 127 devices to be attached to the hubs. In practice, while many devices can be connected, this limit may be unreachable. Some USB devices reserve bandwidth, so it is likely that the maximum bandwidth would be used up before you hit the limit.

IEEE 1394 (FireWire®)

FireWire is another new standard providing plug-and-play capability for FireWire devices such as Digital Camcorders, Scanners and VCRs. Recently, FireWire has become standard on all Mac computers and is slowly expanding into the PC market. Sony has also made use of the IEEE 1394 standard on some of their computers; however, they refer to the standard as "I-link". NTI currently offers FireWire Repeater Hubs, cables and adapters for our customers utilizing this technology, and is exploring the possibility of FireWire applications for KVM switches.

Off-site remote

The newest "hot" trend is towards the Ethernet SNMP protocol for off-site remote. This technology allows a user to access and control the KVM switch from the Internet. UNIX platforms have this technology available, but Windows does not. The entire GUI would be captured and sent over the Internet via TCP protocol. This requires higher bandwidth than terminal emulation.

Currently available KVM technology utilizing this protocol does not produce smooth mouse control for the user. Those considering this technology must also consider the major security issues involved in this protocol.

Flat Panel Display

As new digital flat panel monitors become more popular, NTI is working to upgrade all KVM switch products to recognize this new technology. These new monitors feature digital display with DVI connectors to provide a higher resolution than the current industry-standard monitors do; therefore, manufacturers must develop KVM switches that can provide equivalent output after the data is processed. NTI has incorporated cables and adapters for these monitors into our product line, and is researching the issues involved in creating a product that will allow users of this type of monitor to enjoy the same simple, simultaneous boot-up procedure that our current product line provides.

Internet Keyboards

Keyboards with specialized additional keys for accessing the Internet are starting to appear on the market.

DDC

Future KVM switches must cooperate with "smart" devices and the digital messages they supply. These messages permit a new level of configuration and initializaiton. NTI is working toward full compliance with the *DCC* standard for all of our KVM switches.

Other NTI Features of Note

Testing

NTI performs rigorous testing on all products to ensure you receive the best KVM switch performance possible. NTI tests each unit, burns in each unit for at least 24 hours, and then performs a final test on the unit before shipping it to the customer. Quality is NTI's first concern.

Certification

KeyLabs, an independent testing facility, has tested NTI KVM switches and certified our products as meeting all the requirements for Solaris Ready® and Novell-Yes® certification. NTI is also a member of SPARC® International. This membership provides certification that our products are designed to work with products from other SPARC members.

International

NTI products are available for worldwide use. Wherever you reside, NTI builds units with the proper connectors and sends the appropriate cables for your requirements.

NTI has a worldwide system of distributors for the convenience of our customers. Links to the websites of our distributors can be accessed on the NTI website at www.nti1.com/intldist.html.

Rackmount

NTI's KVM switch line includes 19" and 24" rackmount options for all switches with four or more ports. Some switches include 19" rackmount as standard equipment. Rackmount Universal switches with up to 8 ports are now produced in a 1 RU (Rack Unit) box.

Message Board

The NTIforum is the only Message Board solely dedicated to KVM solutions. The Message Board provides a resource for users to discuss KVM applications with both other users and the NTI sales and technical staff who moderate the discussions. Users can learn about KVM product applications, ask questions, discuss solutions, suggest new products or features to meet their needs, or search archives for information on KVM solutions.

The message board can be accessed from NTI's website at www.networktechinc.com, or directly at http://ntiforum.com/cgi-bin/Ultimate.cgi.

NTI KVM Configurator

In addition to our website, www.nti1.com, NTI has developed a catalog on CD-ROM with a unique configurator program. This configurator will allow you to answer a series of questions regarding your application and the options you prefer, and then uses your answers to produce a list of parts, including any necessary cables or adapters. This list can then be faxed or e-mailed to NTI as an order. To order a free copy of this CD, contact our sales department at 800-742-8324 (toll-free in the US and Canada) or 330-562-7070, or e-mail us at sales@ntigo.com.

Technically Speaking

KVM Switch construction differs from manufacturer to manufacturer, as does the engineering of switch products. There are differences in the processor configuration, video board engineering, and keyboard and mouse recognition and connectors. Different manufacturers have different On Screen Display (OSD) software configurations. Each manufacturer has their own way to present control/switching methods. This section will explore in more detail different aspects of KVM switch technology.

Evolution of KVM switching

There are two types of KVM switches, mechanical and electronic:

Mechanical KVM switches

Mechanical switches (or *passive* switches) use no electronics or intelligent circuitry. Mechanical KVM switches require that the user physically turn a rotary switch to open the computer port channel through which information is passed.

Benefits:

- While mechanical switch procedures can become tedious for large configurations, mechanical switches could fit the bill in small installations, such as Small Office/Home Office (SOHO) environments. In these situations, mechanical KVM switches help keep costs down.

Limitations:

- Limited to manual switching. Users must physically turn a rotary switch to open the computer port channel through which they want to pass information. These passive devices cannot communicate with the computers at the end of each closed channel or interpret the information that passes through the switch.
- Each computer must be booted up individually. While the rotary switch is at a particular computer port, the user can turn that computer on (or "power up"), but then must wait for it to completely boot up (turn on and perform "self-tests") before going to the next computer.
- Mechanical KVM switches often lose the keyboard and mouse on closed computer port channels, which results in errors that require you to restart the affected computer.
- Low video resolution (800x600 maximum) – users who have monitors which have a higher resolution who use a mechanical KVM switch will not receive the full advantage of high-resolution display.
- No PS/2 mouse support (serial mouse only) – users who do not have a serial mouse for the mechanical KVM switch will need to purchase one.

Electronic KVM Switches

Electronic KVM switches (or *active* switches) operate on the same principal as mechanical switches, but utilize one or more *microprocessors* to communicate with the computer. The processor(s) in the KVM switch works like any CPU. The function of the processor is to tell the switch how to "process" data received from keyboard or mouse signals and what to display on the monitor. There are two types of electronic KVM switches – those with one shared microprocessor and those with individual microprocessors.

Shared Processor

Shared Processor electronic KVM switches utilize one processor to communicate with all attached computers, and so are generally less dependable than those with dedicated processors. Since computers require constant contact with the connected keyboard and mouse, switches with shared processors may freeze or go into an error mode. This can happen when a computer

searches for its keyboard or mouse while the switch processor is communicating with another connected computer, as illustrated in *Figure 9*. If the switch is on another port, the searching computer cannot recognize the keyboard and mouse. The problem occurs most frequently in larger installations where a shared processor attempts to keep up with all the computers requiring attention.

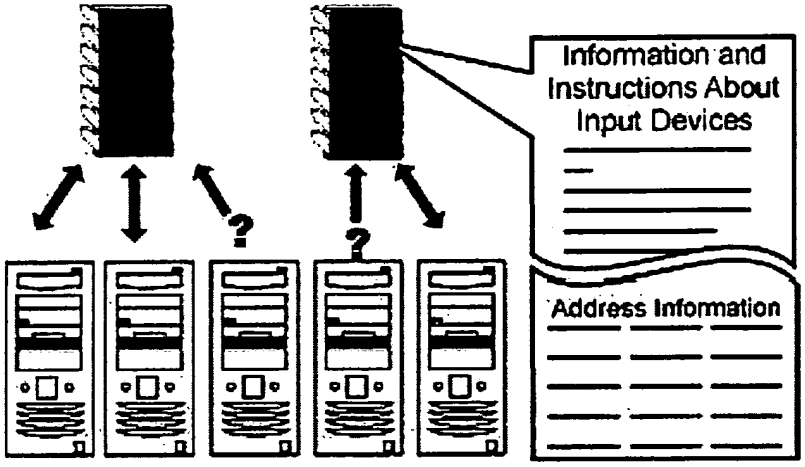


Figure 9 - Shared Processors provide keyboard and mouse information to multiple computers, but can't exchange data with all attached computers all the time.

Benefits:

- The sophisticated internal programming and advanced technology lessens (but does not eliminate) the chance of the computer losing the keyboard and mouse.
- Some manufacturers still use this method because it is less expensive than current technology. In many general applications, this method provides satisfactory results, especially if reliability is NOT critical.
- Most computers can boot-up simultaneously.
- There are several easy ways to select connected computers, depending on the KVM switch model you install:
  - Up/down buttons
  - Rotary knob
  - Autoscan
  - RS232
  - Infrared Remote
  - Keyboard commands
  - Direct selection buttons
  - On Screen Display (OSD) with mouse

Limitations:

- The demands of all the attached computers can cause the occasional system failure.
- Failure of one attached computer may cause failure of the KVM switch.
- Failure of the one shared processor will cause failure of the KVM switch.

Dedicated Processors

Dedicated Processor electronic KVM switches address the problem of system failure. To solve this problem, some manufacturers (including NTI) dedicate a microprocessor to each attached computer for constant keyboard and mouse emulation. This ensures that all attached computers can boot and maintain connections 100% of the time.

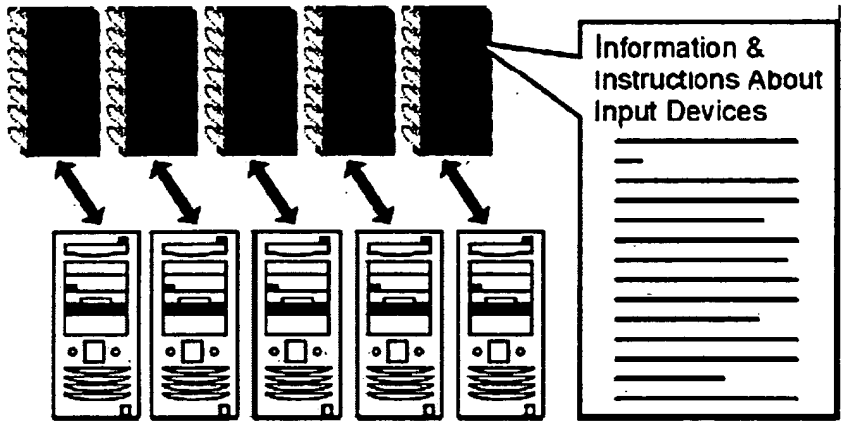


Figure 10 – Dedicated Processors in a KVM switch support a full set of instructions for each attached computer.

Benefits:

- Continuous, fault-free operation. A 1:1 microprocessor to computer ratio is more efficient in processing data and provides the most reliable performance. Each computer connected to the dedicated processor KVM switch receives all the data required for each computer to constantly recognize the keyboard and mouse. Each processor "talks" to only one computer, thus eliminating errors, freezing, or other problems that can occur in the shared processor configuration. This reliability is an important factor if your company cannot tolerate downtime, errors or other catastrophic problems.
- All computers can boot up simultaneously, which decreases start-up time.
- NTI's patented USB KVM switch allows simultaneous boot-up of USB-enabled PCs and Macs. Other USB KVM switches require that each USB computer be booted sequentially, one at a time.
- Failure of one processor will not cause the entire KVM switch to fail – only the port controlled by that processor will fail.

Processor Software

A KVM switch processor can only do what engineers tell it to do. Each processor contains firmware (software code) that gives the switch operating instructions. The firmware engineering determines what systems (CPUs, keyboards, mouse and video) the KVM switch can recognize and how it can process the data for final output to the monitor.

This engineering is where the various manufacturers differ the most. Since so many third-party vendors offer their own computer products, it is nearly impossible to program a KVM switch processor to recognize them all. Most manufacturers concentrate on keeping costs low and therefore provide minimal compatibility with the various systems on the market. A few manufacturers (including NTI) invest in more highly engineered technology to allow maximum compatibility.

Most manufacturers do not invest time into developing a good user interface, which can make use of their KVM switch products cumbersome. Again, a few manufacturers, such as NTI, take that extra time to design a user interface that is intuitive and easy-to-use.

The firmware instructs the processor which protocols should be used to recognize the:

- Mouse, such as PS/2, IBM RS6000, HP9000, and SGI. Specialized products, such as trackballs, touchpads, and graphic tablets, require additional programming. Also, high-end engineering can provide smooth, fluid mouse movement that users appreciate, but few KVM switch manufacturers implement. If the switch manufacturer does not include this movement code, the mouse movement appears jerky and reacts in delayed motion.
- Keyboard, such as IBM, PS/2 and SGI. The firmware instructs the processor on how to recognize keystrokes and take them as commands instead of transparently passing them to the computer, such as when the user presses a key for On Screen Display commands. Some processors can even update the NumLock, Scroll Lock, and Caps Lock status lights on the keyboard for the currently active computer.
- Video, such as the multiscan monitor. Most switches support a *scan* function, which causes the switch to sequentially and incrementally display the video from each connected computer. Most also provide a *broadcast* function that sends data to all the attached computers simultaneously.

Multiple platform and multiple user KVM switch processors require further firmware coding. These switches must act as translators between the switch and the different platform computers attached to it. The transparency of the transition from one platform to another depends on the engineering design.

Keyboard and Mouse Signal Recognition

Keyboards and mice from the three platforms (PC, Sun and Mac) are not compatible. If your computer configuration contains only one platform, your KVM switch selection is simple: a single platform switch meets your needs. However, users who have two or more platforms connected to the KVM switch will need a multiple platform switch that can recognize the different types of computers and signals.

Keyboard Technology

While keyboards for all three platforms are similar and look about the same (generally 85 or 101 keys), the technical working of each platform differs.

- The signals to and from the keyboard travel in 8-bit serial data streams.
- *Scan codes* tell the computer what key (or combination of keys) is depressed and when it is released. The BIOS (whether keyboard or main) translates the scan codes into American Standard Code for Information Interchange (*ASCII*), which lets KVM technology use any key combination desired to initiate tasks.

That's about the last of the similarities of the keyboards across different platforms.

Personal Computers (PCs) need constant communication with the keyboard. If the computer sends out a signal to ensure the keyboard is still present and functional, but does not receive a response, the PC may freeze, or in a worst case scenario, crash. To avoid this problem, the solution is a dedicated processor KVM switch configuration.

Macintosh computers use a separate bus for keyboard signals, but it also carries the mouse signals and other peripherals.

Sun technology is similar to Macintosh in appearance only. The mouse plugs into the keyboard, which then plugs into the computer.

There are diff rences between the keyboard platforms. NTI provides keystroke translation for multiple platform switches. Sun keyboards have 14 extra keys not found on PS/2 101, Win95

and Apple Extended keyboards. NTI offers a keystroke emulation chart for those extra keys, as well as a chart of emergency start-up keys for Sun keyboards.

NTI has the appropriate keyboard connectors for your configuration – NTI products let you use your keyboard of choice, no matter what platform you use. For example, if a user prefers the PS/2 keyboard and attaches SUN or MAC computers to the KVM switch, he or she can use that PS/2 keyboard for all platforms. The NTI KVM switch properly translates the signals for each platform as necessary.

There are differences between the keyboards for different platforms. NTI provides keystroke translations for multi-platform switches. Table 1 identifies the characters and their equivalent keystrokes across the various platforms.

Table 1: Keyboard Equivalency Translation

Sun	PS/2 101	Win95	AppleExt
L-Control	L-Control	L-Control	L-Control
L-Alt	L-Alt	L-Alt	L-Opt
Compose	R-Control	R-Control	R-Control
Alt-Graph	R-Alt	R-alt/Aplcn	R-Opt
Meta	SB+Alt	Logo	Cmnd
Power	SB+RT Arrow	SB+RT Arrow	Power

SB = Space Bar
L and R = Left and right keys when two keys are marked the same on a keyboard

Sun keyboard

Sun keyboards have 14 extra keys not found on PS/2 101, Win95, and Apple Extended keyboards. NTI provides a keystroke emulation chart for those extra keys, as well as an emergency startup keys chart for Sun keyboards. Table 2 provides the keystrokes required on other platform keyboards to emulate the extra keys of the Sun keyboard. Table 3 lists the Sun emergency startup keys.

Table 2: Emulation Keystrokes for Sun's 14 Extra Keys

Sun Key	PS/2, Win95, Mac Keystroke Equivalents
Stop (L1)	SB + F1
Again (L2)	SB + F2
Props (L3)	SB + F3
Undo (L4)	SB + F4
Front (L5)	SB + F5
Copy (L6)	SB + F6
Open (L7)	SB + F7
Paste (L8)	SB + F8
Find (L9)	SB + F9
Cut (L10)	SB + F10
Help	SB + F11
Vol +	SB + Up Arrow
Vol -	SB + Down Arrow
Mute	SB + Left Arrow

SB = Space Bar

Table 3: Sun Startup Keys

Key	Function
Stop	Bypass POST
Stop-A	Abort
Stop-D	Enter diagnostic mode
Stop-F	Enter Forth on TTYA instead of probing
Stop-N	Reset NVRAM contents to default values

Appendix A illustrates the available pin-out configurations for keyboard connectors.

Mouse Technology

Mouse engineering is also different across the three platforms. It is difficult (in fact, almost impossible) to run a Macintosh system without a mouse, but you can operate a PC without one by using keyboard commands.

Since PCs were developed before mouse technology, PC mice standards were developed ad hoc, free-for-all and manufacturers developed three types of mice:

1) bus, which is archaic and now rare,
2) serial, and
3) PS/2, which IBM developed.

- The PC operating system must contain the appropriate driver to recognize the mouse signals. If the computer does not contain the right driver, it cannot recognize the mouse. The use of dedicated processors in NTI KVM switches ensures that each computer recognizes the mouse. Each processor "emulates" the existence of the mouse even when the computer is not active on the switch. Thus, when the computer is activated, it immediately recognizes the mouse movements and commands.
- As mentioned in the keyboard section above, Macintosh mice connect to a separate bus with the keyboard. When you use a Macintosh mouse in a multiple platform configuration, the mouse emulates the PC left- and right-button clicks. (See Table 2.)
- Sun computers use a totally different mouse with its own driver. Similar to the PC, Sun requires the driver installation before the system can recognize the mouse signals.

Video Board Technology

Another differentiating feature in KVM switch construction is in the video board. Switching video without degradation is a bit more difficult than switching the keyboard and mouse. This is an instance where the quality of the components and careful engineering of the KVM switch makes a difference in the final output – in this case, in video resolution and bandwidth.

In most KVM switches, the computer video signal travels through the Printed Circuit Board (PCB) on copper traces. These conductive metal trails direct the individual signals to either the analog or digital switching chips.

- Color signals (red, green, and blue) go to the analog chip.
- Sync signals (horizontal, vertical and composite synchronizing) go to the digital chip (TTL).

- The quality of the analog chip and PCB layout determines its ability to handle high video and bandwidths. Likewise, sync-switching chips vary in their capacity to process digital signals.
- Switching chips allow only the signals from the selected computer to proceed to the amplifiers on the video board, which give the video signals a little boost before they go to the monitor.

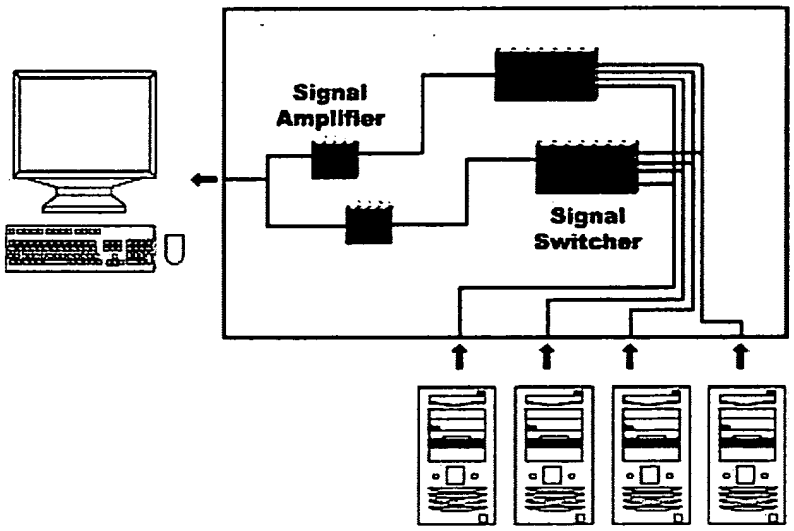


Figure 11 – Basic layout of a Video Switching PCB. The quality of the components and engineering directly affects the quality of the video output.

As *Figure 11* illustrates, video signals travel through a number of conduits before they reach the monitor. Like road surfaces influence the lifespan of tires and the quality of the ride, everything a video signal passes through wears away at the video quality. Each connector and integrated circuit is like a pothole; it has the potential to destroy the quality of the video signal. Because so much of the signal's journey is through cables, the cables play the most important role. Poor quality cables can reduce the distance good video can travel.

When a KVM switch is added to the equation, degradation of video quality is almost inevitable, especially because few switch manufacturers are willing to take the costly and painstaking measures needed to keep the video signal in optimal condition. NTI minimizes video degradation in the switch in two ways:

- We invest in high-quality, fast amplifiers and crosspoint solid-state switches.
- We engineer the design of the PCB to minimize noise and crosstalk.

Cable Quality

Cables carry the signal for much of the journey and significantly affect the final video output. Video signals can travel further on high-quality cables than on poor-quality cables, which can cause ghosting and other video anomalies.

The cables that NTI supplies with its KVM switch product line are the highest quality available on the market today. This regard for high quality standard cables ensures that your video output not only meets but also exceeds your expectations.

NTI's cable distance guide (see Appendix A) will help you determine the cable length you can use for the bandwidth your configuration requires.

Minimizing Noise

A more difficult challenge in engineering the video board and cables is minimizing "noise" and cross talk. Engineers must lay out the copper trails that the signals travel on so that they do not interfere with each other or pick up extraneous "noise" from other components both inside and outside the switch console. The copper line cannot be close to other components or other pieces of the copper.

A highly skilled technician or engineer has to lay out the copper trails that the signals travel on so that they don't interfere with each other, or pick up extraneous "noise" from other components both inside and outside the switchbox. They must then correlate all the board components so that the final signal strength matches the capacity of the cables, ensuring that high-resolution images can travel to the monitor as clearly and sharply as the original generated at the computer. NTI accomplishes this in several ways:

Stripline Technology

NTI uses *stripline technology* to reduce the possibility of noise from the cables. Stripline technology provides a buffer that isolates signals from the rest of the cable data. Each signal travels independently from all other signals, which ensures high quality output. NTI, using this stripline technology, thus provides the widest available bandwidth to eliminate noise: 300MHz.

Impedance matching

NTI also uses *impedance matching* to avoid video noise and signal degradation. Impedance matching ensures that the output signal is the same as the input signal, even over long cables. Generally, longer cables without quality control measures result in poor output quality. The distance the signal must travel greatly affects the quality, especially if the data rate is high. While the signal is adequate over short distances, say 5 to 10 feet, any longer distance increases the degradation of a signal.

Impedance, or Ohms, is a cable characteristic defined by its construction dimensions and materials. An impedance mismatch will cause reflections to occur while the signal is propogating down its electrical path. These signal reflections will appear as ghosted images on the display monitor.

NTI uses cables with impedance matching to ensure that all NTI products maintain bandwidth purity – the signal that goes in the cable leaves the cable in the same high quality manner as the input signal.

Time Domain Reflectometry

NTI also tests long video cables using time domain reflectometry (TDR) to ensure signal quality over long cables (over 250 feet). TDR measures reflection time to avoid offsets. If the signal reflection is too great, the signal quality degrades as it travels along the cable. TDR ensures that the signal R, G, and B will be within ¼ pixel of each other.

RS232 Compatibility

NTI KVM switches are RS232 compatible with the addition of an optional module to the switch console. This configuration is especially good for multiple user applications. This is also a low power consumption application.

When users connect to the RS232 boards, they get on-screen commands rather than the console buttons. This is very helpful when the KVM application resides at a remote location; it eliminates the need for the user to get up and go to the KVM switch console to change to different computer ports or to perform tasks.

The optional RS232 control offers the following features:

- 300-9600 baud rate (DIP switch-selectable)

- Up to 15 DIP switch addresses; daisy chain compatible and one serial port control
- Seven-segment display that shows what input is connected to each output.

The RS232 commands include:

- RS to reset IN1 to OUT1, IN2 to OUT2, and so forth.
- CS to cause one Inx/OUTx connection to occur.
- CA to connect all inputs to specified output.
- RO to read the input that is connected to the specified output.
- RU to read the matrix size and report the inputs/outputs in the specified switch.

KVM Switching Control

The KVM switch technology is similar across manufacturers. As mentioned in earlier sections, the differences occur primarily in the processor firmware engineering, as well as in the physical design.

Whether the KVM switch is for a single platform, multiple platform, multiple user, cascading or classroom application, the process is the same:

1) The KVM switch receives input from the keyboard or mouse.
2) The KVM switch translates the input data to the engineered code.
3) The KVM switch translates the data again to the correct output for the particular computer platform.
4) The KVM switch directs the data to the correct port (and user, where applicable).

The method for switching between connected computers depends on the configuration of the KVM switch you purchase. In its simplest form, the KVM switch console contains buttons that you push to activate computers. In a more complex form, you can select a variety of different functions from an on-screen display.

Push Button Control

The front of the KVM switch console contains buttons that correlate to each port. Simply push the desired button to activate the computer connected to that port. The switch sends signals to that computer and receives output data that appears on the monitor.

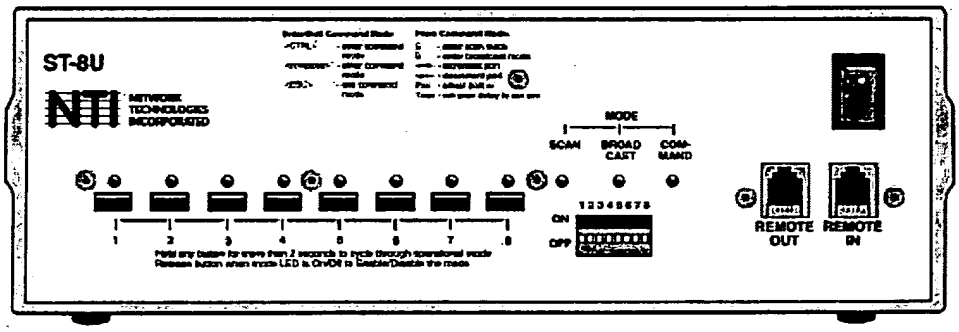


Figure 12 – Front Panel Push Buttons

On some NTI models, pressing the CPU Select button lets the user cycle through three modes of operation: SCAN, BROADCAST and COMMAND. The user simply releases the button when the console indicates the desired mode.

- One flashing CPU port LED = SCAN
- More than one CPU port LED flashing = BROADCAST

- NumLock, Caps Lock, and Scroll Lock illuminated simultaneously on keyboard = COMMAND

Keyboard Control

The user can control switching and send commands via the keyboard. First, enter COMMAND mode by pressing Ctrl and ` (accent key in upper left-hand corner of the keyboard) simultaneously. Most NTI KVM switch products use the following keys to initiate commands:

KEY	FUNCTION
▯ or I	Move to next higher port (increment)
▯ or D	Move to next lower port (decrement)
S	Toggle SCAN mode on/off
B	Toggle BROADCAST mode on/off
Txxx	Set scan time out period on each port, where xxx = number of seconds (001-999)
Pxx	Switch to a specific port, where xx = the port (01, 02 ... 10, 11 ... etc.)

On Screen Display (OSD) Control

OSD helps users easily switch from one computer to another without pushing buttons on the front panel of the switch. It also provides the means to perform other functions that make KVM switch technology even more advantageous than earlier technology allowed.

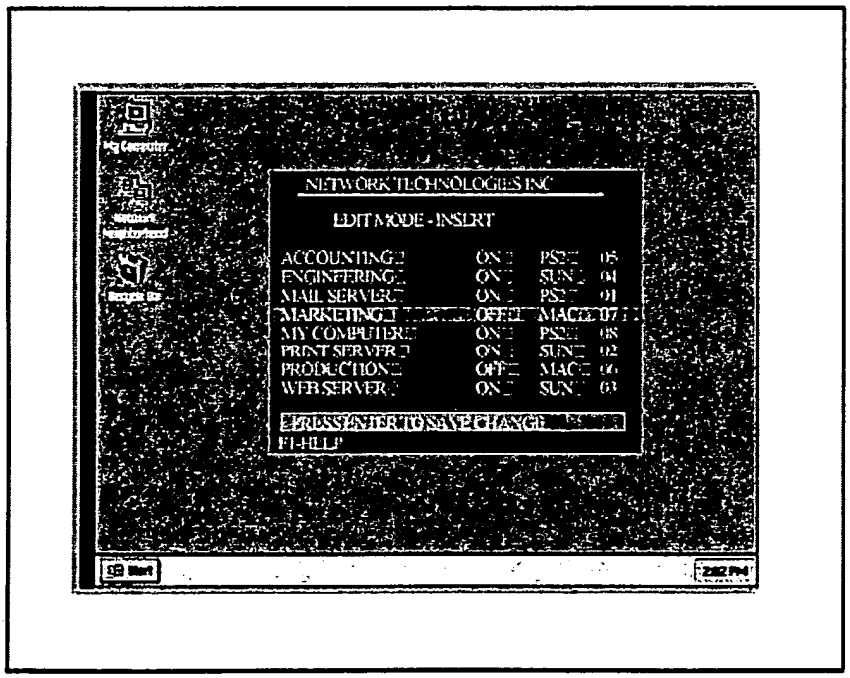


Figure 13– OSD Opening Screen

The user can activate the OSD from any active computer. To activate the NTI OSD, press Ctrl and ` (accent key in upper left-hand corner of keyboard) simultaneously.

NTI's OSD lets you perform the following functions by keyboard and mouse control *or* front panel control:

- Name or rename each connected computer.
- "Select" a particular computer.
- Search for a particular computer connected to the KVM switch – this is particularly helpful when users connect many computers to the KVM switch application. For example, if the user controls 40 computers from his or her workstation, it may take a while to find a computer in the port listing since the OSD displays only eight names at one time. Search mode goes directly to the desired computer listing.
- Scan all computers – the NTI default scan interval is 5 seconds. A computer is active for 5 seconds, then the switch selects the next powered-on computer as active.
- Set a scan interval from 2 to 255 seconds.

NTI's LCD display also lets the user do the listed functions. In that case, the user can press buttons on the switch console or use keyboard commands. An LCD screen on the console shows the appropriate information.

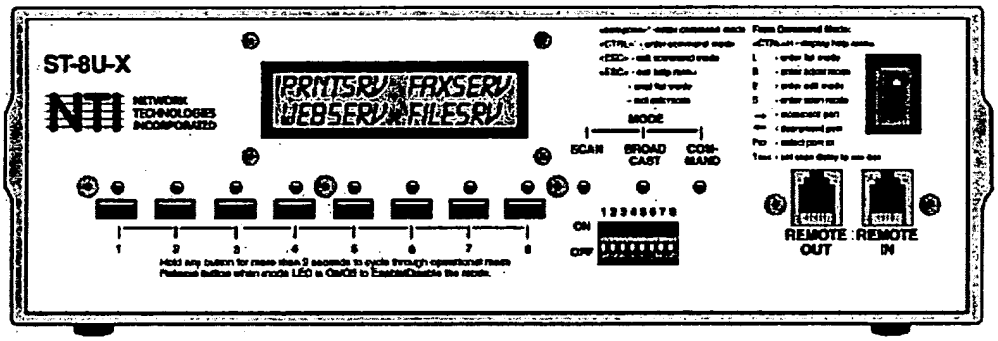


Figure 14– LCD Front Panel

Multiple User / Multiple Platform KVM Switches

The dedicated processors in NTI's Modular Matrix multiple user/multiple platform KVM switches ensure reliable performance at all times. Each port has its own processor that emulates the keyboard and mouse for the connected computer. This means that even PCs will not crash because the computer will always "recognize" the attached mouse and keyboard, even when the switch activates another computer.

The power cycling utilized by NTI's Sun KVM switch ensures that users can power the KVM switch up or down without crashing the operating system on the attached computers. This feature can also be utilized on NTI Universal and Universal Matrix KVM switches configured for the attached SUN computers.

NTI's Modular Matrix multiple user/multiple platform KVM switches are also reconfigurable as needs change. Plug-in cards make this possible. These cards are removable from the KVM switch so if an application changes and the network administrator wants to use a port for a computer of a different platform, all he need do is purchase the card, install it, and connect the computer. This eliminates the need to purchase a whole new KVM switch.

Directional control ensures that the data retains its integrity and goes to the correct computer after the KVM switch processes the information. Directional control also ensures that the output

goes to the correct user in the multiple user application. Up to eight users can control as many as 32 computers on the modular matrix multiple user/multiple platform unit.

NTI's multiple platform KVM switches lets users choose whichever keyboard and mouse platform they prefer. The KVM switch recognizes the signals from each platform and translates the data to the appropriate platform as necessary. This feature, unique to NTI, lets users continue to use their favorite control console.

Also, when more than one user selects the same computer, the KVM switch recognizes ALL keystrokes and mouse movements from each user. The switch processes the signals and returns the output to all user monitors – all users on the same computer see everyone else's input, including their own.

Dual Redundant Power (DRP)

NTI's Modular Matrix multiple user/multiple platform KVM switches are available with an optional dual redundant power supply feature. This separate unit adds a backup power supply to each of the switch's voltage levels. This ensures that a power failure in one power supply does not take your KVM switch system down because the backup automatically kicks in. Users can then replace the failed power supply without interrupting the operation of the switch or requiring the powering down of the attached computers.

Classroom Applications

One of the most innovative ways to use KVM switch technology is in the classroom. NTI's KVM Classroom Commander gives the teacher, trainer, or instructor complete control of up to 32 computers in a class. Through daisy chaining, instructors can have an interactive role with each student. They can observe students working or send out video to the entire class.

The instructor's video, keyboard, and mouse connect to a central box that contains eight ports for communication and eight ports for video interface from student computers. Each port supports a chain of up to four students for a total of up to 32 connected computers.

- The keyboard and mouse ports support 6-pin miniDIN female connectors for PS/2 systems. For serial mouse systems, a converter is available.
- The video ports are 15-pin HD female connectors for VGA monitors. The unit supports a video bandwidth of 150 MHz and 1600x1200 resolution.
- The unit supports either 110 or 220 VAC power sources at 50 or 60Hz.
- Each unused communication port requires a terminator, available from NTI.

The student computers connect to a unit with connectors for the keyboard, mouse and video, as well as two communication ports and two video ports. Up to four computers are chained through the communication and video ports to the central unit. The last student unit on the chain requires a terminator on the unused communication and video ports. NTI has these terminators available upon request. The last unit in the chain must be within 50 feet of the central unit.

- The keyboard and mouse ports support 6-pin miniDIN female connectors for PS/2 systems. For serial mouse systems, a converter is available.
- The video import ports are 15-pin HD female connectors for VGA monitors and connect to the instructor's central unit.
- The video output port connects to the next computer in the chain with a 15-pin HD male connector. The unit supports a video bandwidth of 150 MHz and 1600x1200 resolution.
- The students' units require no external power – they draw power from the keyboard and mouse ports on the CPU.

- The instructor can "control" the classroom with on screen display (OSD) commands. From the Main Menu, the instructor can go to submenus to perform various tasks, as follows:

Main Menu Item	Description
INHIBIT	Displays the Inhibit menu to enable or disable keyboard and mouse of one or more students. Students can see their own video.
BLANK	Displays the Blank menu to disable the keyboard, mouse **and** video of one or more students. The student monitor goes blank.
BROADCAST	Displays the Broadcast menu to select a video source and send it to any or all of the student monitors while disabling the student keyboards and mice. The instructor can broadcast their own video to students or broadcast a student's video to other students.
SCAN	Displays the Scan menu to let the instructor monitor the active student videos without interfering with the students' work.
OVERRIDE	Displays the Override menu, from which the user can select which computer to control and a control source. This lets the teacher control a student's computer or lets a student control another student's computer.
NAME ENTRY	Displays a list of numbers corresponding to connected computers with fields to enter students' names.
STATUS STATUS (cont.)	Displays current system status: <u>First column</u> • L = Local mode • S = Screen Save Mode • R = Remote connection <u>Second Column</u> • B = Blanked • I = Inhibited <u>Third Column</u> • * = Viewing own video • D = Receiving video from another source • S = Student is OVERRIDE source
SETUP	Gateway menu to set up scan mode time, screen saver set up, and diagnostic mode menu.

Presentation Applications

Another interesting use of KVM switches is for presentations that use data from several computer sources to one or more monitors. NTI's Video Matrix Switch allows up to 32 video sources to output to any or all of up to eight monitors. This unit, which NTI builds to order, supports either 100 or 200MHz bandwidths and resolutions through to 1900x1200 with no degradation.

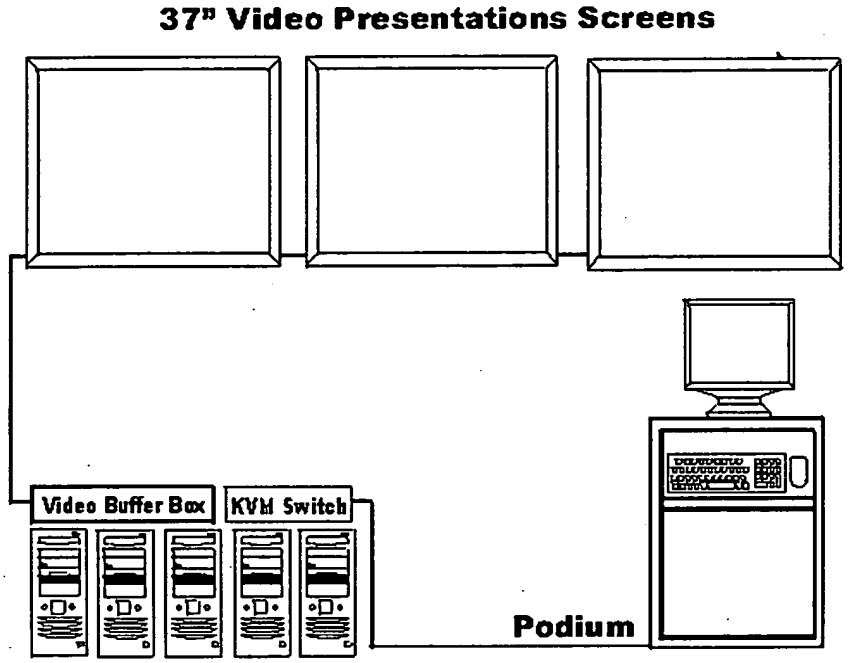


Figure 15 – Presentation Application

Switch control is also made-to-order by NTI: infrared wireless remote, or RS232 (which requires a DIPswitch configuration).

The KVM switch unit uses output ports for up to eight monitors for presentation display. The unit also contains the desired number of input ports (up to 32) for each computer that will send data to the presentation monitors. NTI also installs the appropriate connector for the selected control method.

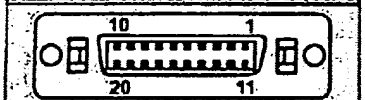
- For wired remote units, the presenter selects an output cluster that also indicates the input selection.
- For infrared remote units, the presenter first selects an output destination, then selects the input source.
- The RS232 interface meets RS232C standards. Any host computer can control the system, but the program must send an entire command line at once (not character by character). HyperTerminal in Windows does not work with this system.

Appendix A

The following illustrations and charts provide pin-out designations for the different types of keyboard, mouse and video connectors compatible with NTI's KVM switch product line.

The Cable Distance Guide lays out the maximum distance for each cable type and bandwidth to achieve optimal performance from your cables.

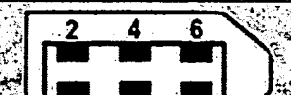
Digital Flat Panel DFP Port



Mating face of MDR20 female

PIN#	SIGNAL	PIN#	SIGNAL
1	TX1+	11	TX2+
2	TX1-	12	TX2-
3	SHLD1	13	SHLD2
4	SHLDC	14	SHLD0
5	TXC+	15	TX0+
6	TXC-	16	TX0-
7	GND	17	NC
8	+5V	18	HPD
9	NC	19	DDC DAT
10	NC	20	DDC CLK

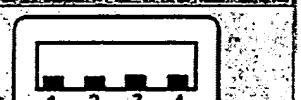
IEEE 1394



Mating face of 6 pin male firewire

PIN#	SIGNAL
1	POWER
2	GND
3	TPB-
4	TPB+
5	TPA-
6	TPA+

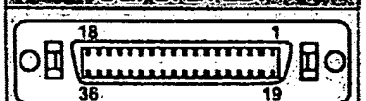
IEEE 1394A



Mating face of 4 pin male firewire

PIN#	SIGNAL
1	TPB-
2	TPB+
3	TPA-
4	TPA+

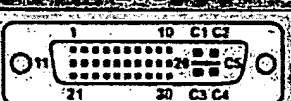
SGI OPEN LDI



Mating face of MDR36 female

PIN#	SIGNAL	PIN#	SIGNAL
1	LINK2 D0-	19	LINK2 D3-
2	LINK2 D0+	20	LINK D3+
3	LINK2 D1-	21	LINK2 CLK-
4	LINK2 D1+	22	LINK2 CLK+
5	LINK2 D2-	23	DDC CLK SCL
6	LINK2 D2+	24	VCC
7	NC	25	DDC DATA SDA
8	NC	26	GND
9	GND	27	NC
10	GND	28	GND
11	NC	29	NC
12	NC	30	NC
13	LINK1 D0-	31	NC
14	LINK1 D0+	32	GND
15	LINK1 D1-	33	LINK1 CLK-
16	LINK1 D1+	34	LINK1 CLK+
17	LINK1 D2-	35	LINK1 D3-
18	LINK1 D2+	36	LINK1 D3+

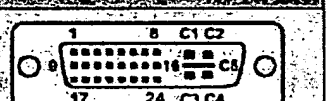
EVC



Mating face of EVC female

PIN#	SIGNAL	PIN#	SIGNAL
1	T.M.D.S DATA 2 +	19	1394 VG
2	T.M.D.S DATA 2 -	20	1394 VP
3	T.M.D.S DATA 2 RTN	21	T.M.D.S DATA 0 -
4	SYNC RTN	22	T.M.D.S DATA 0 +
5	HORIZ. SYNC TTL	23	T.M.D.S DATA 0 RTN
6	VERTICAL SYNC TTL	24	STEREO SYNC TTL
7	T.M.D.S CLOCK RTN	25	DDC RTN
8	CHARGING PWR INPUT +	26	DDC DATA SDA
9	1394 PAIR A, DATA -	27	DDC CLOCK SCL
10	1394 PAIR A, DATA +	28	+5 VDC
11	T.M.D.S DATA 1 +	29	1394 PAIR B, CLOCK +
12	T.M.D.S DATA 1 -	30	1394 PAIR B, CLOCK -
13	T.M.D.S DATA 1 RTN	C1	RED VIDEO OUT
14	T.M.D.S CLOCK +	C2	GREEN VIDEO OUT
15	T.M.D.S CLOCK -	C3	PIXEL CLOCK OUT
16	USB DATA +	C4	BLUE VIDEO OUT
17	USB DATA -	C5	COMMON GND RTN
18	1394 SHIELD/CHARGING POWER INPUT-		

DVI



Mating face of DVI female

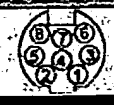
PIN#	SIGNAL	PIN#	SIGNAL
1	T.M.D.S DATA 2 -	16	HOT PLUG DETECT
2	T.M.D.S DATA 2 +	17	T.M.D.S DATA 0 -
3	T.M.D.S DATA 2/4 SHIELD	18	T.M.D.S DATA 0 +
4	T.M.D.S DATA 4 -	19	T.M.D.S DATA 0/5 SHIELD
5	T.M.D.S DATA 4 +	20	T.M.D.S DATA 5 -
6	DDC CLOCK	21	T.M.D.S DATA 5 +
7	DDC DATA	22	T.M.D.S CLOCK SHIELD
8	ANALOG VERT. SYNC	23	T.M.D.S CLOCK +
9	T.M.D.S DATA 1 -	24	T.M.D.S CLOCK -
10	T.M.D.S DATA 1 +		
11	T.M.D.S DATA 1/3 SHIELD	C1	ANALOG RED
12	T.M.D.S DATA3-	C2	ANALOG GREEN
13	T.M.D.S DATA3+	C3	ANALOG BLUE
14	+5V POWER	C4	ANALOG HORZ SYNC
15	GND	C5	ANALOG GROUND

PS/2 Keyboard or Mouse

Mating face of 6 pin miniDIN female

PIN#	SIGNAL
1	DATA
2	NC
3	GND
4	+5
5	CLOCK
6	NC

Sun Keyboard & Mouse



Mating face of 8 pin miniDIN female

PIN#	SIGNAL
1	GND
2	GND
3	+5
4	MOUSE
5	KYBD RCV
6	KYBD XMT
7	PWRN
8	+5

Mac Keyboard

Mating face of 4 pin miniDIN female

PIN#	SIGNAL
1	DATA
2	PWRN
3	+5
4	GND

PC/AT Keyboard

Mating face of 5 DIN female

PIN#	SIGNAL
1	CLOCK
2	DATA
3	NC
4	GND
5	+5

Silicon Graphics Kybd/Mse

Mating face of 6 pin miniDIN female

PIN#	SIGNAL
1	KYBD DATA
2	MOUSE DATA
3	GND
4	+5
5	KYBD CLOCK
6	MOUSE CLOCK

Mac Video

Mating face of 15D male

PIN#	SIGNAL	PIN#	SIGNAL
1	GND	9	BLUE
2	RED	10	ID3
3	CSYNC	11	GND
4	ID1	12	VS
5	GREEN	13	GND
6	GND	14	GND
7	ID2	15	HS
8	NC		

VGA Video

Mating face of 15HD male

PIN#	SIGNAL	PIN#	SIGNAL
1	RED	9	NC
2	GREEN	10	GND
3	BLUE	11	ID0
4	ID2	12	ID1
5	GND TEST	13	HS
6	GND	14	VS
7	GND	15	ID3
8	GND		

Sun & SGI Video

Mating face 13W3 female

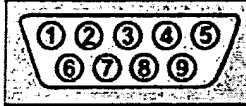
PIN#	SIGNAL	PIN#	SIGNAL	PIN#	SIGNAL
1	GND	6	HSYNC	A1	RED
2	VSYNC	7	GND	A2	GREEN
3	ID2	8	ID1	A3	BLUE
4	GND	9	ID0		
5	CSYNC	10	GND		

MA, HERC, CGA, EGA

Mating face of 9D male

PIN#	MA & HERC	CGA	EGA
1	GND	GND	GND
2	GND	GND	RED2
3	NC	RED	RED
4	NC	GREEN	GREEN
5	NC	BLUE	BLUE
6	INT	INT	GRN2
7	VID	NC	BLU2
8	HS	HS	HS
9	VS	VS	VS

Serial Mouse



Mating face of 9D male

PIN#	SIGNAL
2	RX
3	TX
4	DTR
5	GND
7	RTS

Universal Serial Bus

Mating face of USB Type A female

Mating face of USB Type B female

PIN#	SIGNAL
1	+5
2	- DATA
3	+ DATA
4	GND

Cable Distance Guide

Cable Type	Bandwidth Megahertz	Distance (Feet)	Cable OD (in.)
miniRG59	25	250	.15
miniRG59	50	150	.15
miniRG59	100	100	.15
RG59	25	250	.242
RG59	50	150	.242
RG59	100	100	.242
RG6	25	300	.270
RG6	50	200	.270
RG6	100	150	.270
RG11	25	500	.405
RG11	50	300	.405
RG11	100	200	.405

CEXT Video Cable

- OD .8 inches
- 4 RG59 coax
- 4 twisted lo-cap pairs
- PVC jacket

Glossary

active switch	An electronic switch in which one or more microprocessors communicate with the attached computers; an electronic KVM switch.
ASCII	Abbreviation of *American Standard Code for Information Interchange* – a standard language for the transmission of information.
attenuation	Signal loss; the reduction of signal amplitude.
authorized access	A feature of OSD which allows a network administrator to restrict access to particular computers to particular control stations and/or users.
BIOS	Abbreviation of *Basic Input Output System* – the hardwired operating system utilized to start up a computer.
bandwidth	The capacity of a signal route – the higher the bandwidth, the higher the capacity for information transfer. 1. The frequency limits between which a device or circuit transmits ac energy with negligible loss. 2. possessing the ability to allow passage of signals at a given frequency or band of frequencies while disallowing passage of other signals. (Source: *Illustrated Dictionary of Electronics*, 4th Ed., Turner and Gibilisco)
cascading	A method of attaching KVM switches to each other in order to expand the number of computers which may be controlled from one control console.
control station	A set of peripherals (i.e., keyboard, monitor and mouse) used to control attached KVM switches and/or computers.
DDC	Abbreviation of *Display Data Channel*, a VESA standard for communication between a monitor and a video adapter. Using DDC, a monitor can inform the video card about its properties, such as maximum resolution and color depth. The video card can then use this information to ensure that the user is presented with valid options for configuring the display. (Source: www.webopedia.internet.com)
dedicated processors	A microprocessor configuration used in a KVM switch in which one microprocessor is dedicated to communication with one attached computer, as opposed to a shared processor conformation in which one microprocessor handles communication for multiple computers.
electronic KVM switch	A KVM switch which utilizes one or more microprocessors to communicate with the attached computer(s); an active switch.
GUI	Abbreviation of *Graphical User Interface* – a program interface utilizing the computer's graphics capabilities (such as icons and drop-down menus) to make a program easier to use, as opposed to utilizing only keyboard commands.
hot plugging	The ability to add and remove devices to a computer while the computer is running and have the operating system automatically recognize the change. NTI KVM switches that are described as hot pluggable allow the user to add and remove computers and/or peripheral devices to the KVM switch without powering down the KVM switch. (NOTE: it is recommended that computers being added or removed to the KVM switch be powered down.) Other attached computers do not perceive any loss of keyboard or mouse, and thus are not disrupted by the change.
impedance matching	A measure utilized to ensure a high-quality signal over long distances of cable; the adjustment of impedances so they equal each other, or the insertion of a suitable transformer between different impedances to accomplish the same purpose.
infrared wireless remote	A method of controling a KVM switch from up to 50 feet away. The KVM switch is equipped with an infrared signal receiver; the user then controls the KVM switch by utilizing a remote control with an infrared signal transmitter.
keylock access	A method of limiting access to a KVM switch. Authorized users must possess a key, which must be inserted and turned before the KVM switch will accept commands.
KVM switch	A keyboard-video-mouse switch device which allows multiple computers to be controlled from one or more control stations.
LCD	Abbreviation of *Liquid Crystal Display*. A method of controlling a KVM switch in which

	the Liquid Crystal Display provides feedback to keyboard or touch-button commands, such as the names assigned to the attached computers, scan dwell time and port selection.
legacy	A term for computers not equipped with USB ports.
master switch	A term used in cascade applications. This refers to a KVM switch which has additional KVM switches attached via the computer ports, thus expanding the total number of computers which can be controlled by one keyboard, monitor and mouse. The master KVM switch can be a 4, 8, 16 or 32 port KVM switch. See the section on Cascading for additional information.
mechanical KVM switch	A KVM switch which does not utilize microprocessors to communicate with the attached computers; a passive switch.
microprocessor	A single-chip computer element that contains the control unit, central processing circuitry and arithmetic and logic functions and is suitable foruse as the central processing unit of a microcomputer or a dedicated automatic control system. (Source: *Illustrated Dictionary of Electronics*, 4th Ed., Turner and Gibilisco)
network	A group of two or more computer systems equipped with hardware and software to allow shared access.
OSD	Abbreviation for *On Screen Display*. A method of controlling a KVM switch that provides an on-screen menu providing feedback to the user regarding the status of attached computers in response to keyboard or mouse commands, such as port information, names of assigned computers, computer platform, etc.
ohm	(Symbol: Ù) The basic unit of resistance, reactance or impedance. A resistance of 1 ohm passes a current of 1 ampere in response to an applied emf of 1 volt. (Source: *Illustrated Dictionary of Electronics*, 4th Ed., Turner and Gibilisco)
passive switch	A KVM switch which does not utilize microprocessors to communicate with attached computers; a mechanical KVM switch.
platform	The type of computer (i.e., Sun, Macintosh, PS/2, etc.), a standard around which a system can be developed; often used as a synonym of operating system.
RS232	Abbreviation of *recommended standard-232C*, a standard interface approved by the Electronic Industries Association (EIA) for connecting serial devices. This standard is utilized in a method of controlling KVM switches in which a module is built into the switch console which allows users to utilize on-screen commands rather than console buttons. This low-power consumption application is helpful when the KVM application resides at a remote location, and is particularly well-suited to multiple user applications. See the Section on RS232 Compatibility for additional information.
scan codes	A code which tells the computer which key (or combination of keys) is deparesed and when it is released. Utilized in KVM technology to initiate tasks.
security features	Authorized access features of the OSD system used on NTI matrix KVM switches which allow the network administrator to assign user names and passwords. The administrator can then enable or disable all security features and select which computers each user can access. Once enabled, a user or administrator must "login" in order to access any of the computers connected to the switch.
shared processors	A microprocessor configuration used in a KVM switch in which one microprocessor is dedicated to communication with more than one attached computer, as opposed to a dedicated processor configuration in which one microprocessor handles communication for only one computer.
slave switch	A term used in cascade applications. This refers to a KVM switch which has been attached to the "master" KVM switch via the computer ports, thus expanding the total number of computers which can be controlled by one keyboard, monitor and mouse. Any KVM switch with more than 2 ports may be utilized as a slave. All slaves must have the same number of ports. See the section on Cascading for additional information.
stripline technology	A technology which provides a buffer that isolates signals from the rest of the cable data, used to reduce the possibility of noise from cables.
TDR	Abbreviation of *Time Domain Reflectometry*. A quality control measure of relfection time to avoid offsets, thus decreasing signal degradation; measuring the reflective characteristics of a device or system by superimposing upon a time-calibrated

	oscilloscope screen the direct and reflected components of a step-formed test signal. (Source: *Illustrated Dictionary of Electronics*, 4th Ed., Turner and Gibilisco)
terminate	To "cap off" a video sign.
translating switch	A KVM switch whose software allows it to talk between different keyboard and mouse types and computers attached to the switch.
USB	Abbreviation for *Universal Serial Bus*, a new external bus standard that supports data tranfer rates of 12 Mbps. A single USB port can be used to connect up to 127 peripheral devices, such as mice, modems, and keyboards. USB also supports Plug-and-Play and hot plugging.
Universal Multi-Platform KVM Switch	A KVM switch which allows one user to control multiple computers, which can be composed of a mix of platforms (i.e., Sun, Macintosh and PS/2).
Universal Matrix KVM Switch	A KVM switch which allows multiple users to control multiple computers, which can be composed of a mix of platforms (i.e., Sun, Macintosh and PS/2).
video format	Signal format; the style of video utilized by a monitor (i.e., RGB, RGBS, or RGBHV)
video resolution	The number of pixels transmitted to the monitor (i.e., 1900x1200, 800x600). The higher the resolution capacity, the greater the detail in the resulting image.
workstation	An individual computer and control console attached to a network.